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Acetylcholinesterase sensors based on gold electrodes modified with dendrimer and polyaniline A comparative research

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Abstract

Potentiometric and amperometric enzyme sensors based on modified gold electrodes have been developed and compared in pesticide determination. PAMAM dendrimer (generation G4) stabilized with 1-hexadecanethiol was used for the immobilization of acetylcholinesterase from electric eel and choline oxidase from *Alcaligenes* species in the assembly of amperometric sensor. Polyaniline-doped with camphorsulfonic acid was used to obtain potentiometric response. Trichlorfon, carbofuran and eserine suppress the biosensor response due to their inhibitory effect. The detection limits of 0.003 and 200 nmol l^{-1} (trichlorfon), 0.04 and 6 nmol l^{-1} (carbofuran) and 0.1 and 700 nmol l^{-1} were obtained for amperometric and potentiometric sensors, respectively. The difference in the biosensor behavior and the high sensitivity of the dendrimer modified sensor to the inhibitors is due to the specific organization of protein layer at charged surface of the modifier macromolecules.

Keywords: Dendrimers; Polyaniline; Cholinesterase; Enzyme sensor

1. Introduction

The increasing amount of potential harmful pollutants released in the environment calls for the development of fast and sensitive analytical techniques for their monitoring. The cost and complexity of traditional analytical methods, e.g. chromatography, limits their application on regular basis, especially in field. In this respect, biosensors are considered as suitable complementary tools for preliminary screening of toxic species and environmental risk assessment.

The application of enzymes in the assembly of biosensors developed for environmental monitoring is commonly based on quantification of their inhibition in the presence of hazardous species. Thus, organophoshorus and carbamic pesticides, heavy metals and detergents exert strong specific inhibition of acetylcholinesterase (AChE) which can be measured either amperometrically or potentiometrically. The sensitive and selective detection of the anticholinesterase pollutants was realized in the enzyme sensors of different assembly (see reviews [1–4]).

There are two strategies for amperometric detection of AChE activity, i.e. the use of synthetic substrates (thiocholine ethers) Eq. (1) [5,6], or the implementation of a second enzyme providing consecutive conversion of native substrate (acetylcholine) to electrochemically active products. In the first case, acetylthiocholine is enzymatically converted to thiocholine which can be easily oxidized into appropriate disulfide.

$$\text{acethylthiocholine} + H_2O \xrightarrow{\text{AChE}} \text{thiocholine} + \text{acetic acid}$$
$$\text{2-thiocholine} \xrightarrow{\text{anodic oxidation}} \text{disulfide} + 2H^+ \quad (1)$$

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